Printing Walkable Visualizations

Dario Rodighiero dario.rodighiero@epfl.ch
École polytechnique fédérale de Lausanne (EPFL), Switzerland

Photo: from left Dario Rodighiero (EPFL), Prof. Frédéric Kaplan (EPFL), and Prof. Bruno Latour (Sciences Po) at DH2014 @ Giorgio Uboldi, (Calibro)

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Dario Rodighiero
École polytechnique fédérale de Lausanne (EPFL)
Lausanne, Switzerland
dario.rodighiero@epfl.ch

Abstract

This article concerns a specific actor in the actualization process, the media. The conventional media for visualizations is the computer screen, a visual device that supports the practices of design and reading. However, visualizations also appear in other ways, for example as posters, articles, books, or projections. This article focuses, in particular, on a pretty unusual medium called floor or walkable visualization.

Author Keywords

Actualization; Floor Visualization; Digital Humanities; Data Visualization; Reading; Visual Representation.

ACM Classification Keywords

Human-centered computing; Visualization; Empirical studies in visualization.

Introduction

Visualizations are created through the process of *actualization*, which transforms ideas into tangible artifacts ready to be used. Actualizing a data *visualization*, hereinafter referred to as visualization for the sake of brevity, is a complex process that requires the contribution of several actors. To get a real sense of its complexity, it should be remembered that actual visualizations cannot exist without all of their possible variations. This fascinating picture was conceived by

Gilles Deleuze to describe the sense of multiplicity that is hidden behind each artifact [4:148]. This multiplicity relies on the contribution of human and non-human actors such as the author, the client, the data, and the media. All of them contribute in different ways to actualize a visualization by making it an interactive object.

This article concerns a specific actor in the actualization process, the media. The conventional media for visualizations is the computer screen, a visual device that supports the practices of design and reading. However, visualizations also appear in other ways, for example as posters, articles, books, or projections. This article focuses, in particular, on a pretty unusual medium called floor or walkable visualization. Walkable visualizations correspond to a specific type of actualization, or physicalization [13]. They take the form of a large print format that is laid on the ground in order to invite people to be part of a collective reading. This article deals with this subject matter through two empirical case studies, which will now be illustrated and discussed in more depth.

Digital Humanities 2014

The first case study happened in 2014, during the Digital Humanities conference. A round sticker with a diameter of six meters was printed and stuck to the ground in front of the entrance to the SwissTech Convention Center in Lausanne (see figure 1). Shown on its surface was a network visualization with all the authors that contributed to the conference. The nodes of the network represented these authors, who were linked and situated according to their co-authorship and publication keywords [25]. The idea was to brand the conference with this network composed of around eight hundred highly connected nodes using different media: social networks, posters, web sites, email messages, mugs, t-shirts, etc. [22]. For the opening, another very special media was created in order to welcome the conference attendees, the network was actualized in a walkable visualization. In other words, attendees were invited to explore it by walking directly on it. Although they were initially afraid of doing so because the sticker was brand new, after a while the instinct of exploration guided them to walk on the sticker.

Figure 1: The walkable visualization presented a network of all the authors accepted to the Digital Humanities conference.

Before printing the sticker, there was a discussion about the network model. Doubt still lingered over whether it would be better to use keywords or the names of individuals to represent the nodes. Which type would have been better for grabbing the interest of the attendees? Keywords would have provided a map of the discipline, which might have depicted the identity of Digital Humanities and the role of the digital humanist within its community [9]. On the other hand, individuals would have represented the authors of the conference, helping to remind attendees that a discipline is pursued by a community and its members. The final choice was to use the individuals instead of the keywords. Individuals were considered more appropriate in order to celebrate the scientific collective that has been building a little bit at a time.

Figure 2: Brian Corxall asks for a portrait when lying next to his research group [3].

It was a great pleasure seeing the attendees enjoying the walkable visualization. Their comprehension of what the visualization represented was immediate. After a brief moment of studying it, attendees were engaged in searching for themselves as in a sort of gamification of social networks. Portraits and selfies posted to Twitter by attendees were used to celebrate the successful discovery of themselves on the visualization (see figure 2). The browsing also led attendees to find their acquaintances by retracing the social ties that define the community structure. The search in the walkable visualization was not only an operation of self-recognition, but also a way to understand the diversity of individuals contributing to the Digital Humanities community.

Displaying a public visualization of the Digital Humanities community members was a way to welcome attendees to the conference. However, from the beginning of the conference we realized how strong the message of the visualizations was. Members of the discipline were proud to be publicly represented, likewise the distribution of the conference proceedings. Authors were happy to be shown in the visualization, but at the same time some people were excluded, like the attendees without a publication. For instance, a complaint was made from a member of the organizing committee, who asked us to modify the visualization to add all of them. Of course, that was impossible since the branded object had been produced the previous week, including the walkable visualization. However, such a compliant was very interesting. It was proof of people's attachment to the community as well as its representation, and turned us towards a general reflection about the difficulty in creating a public representation of individuals.

Creating a walkable visualization requires a lot of preparation. The first thing to do is to check the budget, as large printing can be very expensive. Then it is necessary to find a professional in large format printing. The sticker for the first case study was sponsored by the conference, and the work was commissioned to a company based in Lausanne, which specialized in visual communication for public events. This company could print on slip-resistant surfaces that had been especially conceived for external use.

The visualization of the Digital Humanities conference was initially created with Gephi, a tool for network analysis [2]. All the relevant data concerning the conference publications were treated and imported into this software through an algorithm written in R. Successively, the nodes were situated using the Fruchterman-Reingold algorithm, which optimizes the use of circular space, providing a pleasant geometrical arrangement [7]. The network was exported in vector graphics and modified through Adobe Illustrator in order to customize colors and assure its readability (see figure 3). As floor visualizations have no standards that indicate an appropriate typography, the layout was based on some tests performed by reading the network at the distance of a standing person, which is around 1.70 meters. Finally, the labels of the nodes were set up at 56 points using the Myriad Pro font on a neutral background color, while the thickness of the links was balanced to reduce the visual noise.

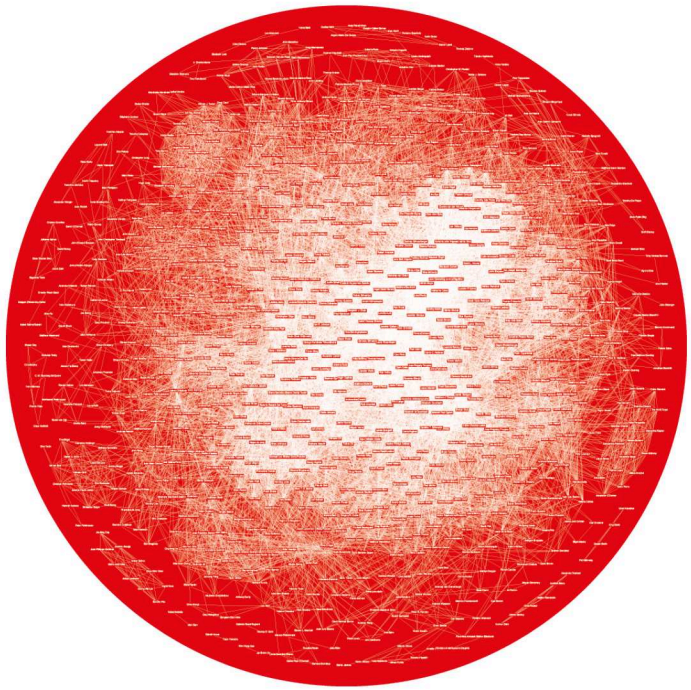

Figure 3: A reproduction of the final PDF file used to print the six-meter visualization for the Digital Humanities conference.

Visualizations in the Environment

The case study of the Digital Humanities conference allowed for the identification of three qualities that make visualizations walkable; namely, orientation, location and size. This section begins by introducing these qualities that, successively, were used to define the *environment*, a concept used to make the complexity of visualizations visible.

The *orientation* of computer screens, for example, highly typifies visualizations. These devices, usually upright, face towards the readers in front of them and hide who is behind them. A horizontal orientation, on the contrary, avoids exclusions and invites readers to access the visualization from any direction.

Making a visualization accessible from any direction means an appropriate *location* must be chosen. In many war movies, for instance, the military intervention is planned around a table where a map lies horizontally. This specific location greatly encourages social interaction, but at the same time it limits the size of the map. The information at the center of the map, indeed, has to be readable from the borders. Thus, the map cannot exceed a given dimension. If it does exceed a certain dimension then the readers should be able to enter the map.

Indeed, entering the map is necessary when its *size* oversteps the limits of the table-location readability. During the seventeenth century, the astronomer Giovanni Domenico Cassini directed the drawing of a planisphere on the floor of the Parisian observatory [12:94]. Centered on the North Pole, the planisphere represented the known world with a new technique of measuring. Cartographers were invited to walk on it to assess the precision of the new measure, which should have produced improvements in the longitudinal projection. The Cassini drawing substantially exceeded the usual size of the maps occupying a larger surface area. Such a size drastically changed the behavior of the readers. They were not forced to stay outside the map anymore; rather, they were invited to enter it and walk on a cartographic version of the world. From this example, it can be observed that size is an essential consideration for visualizations in order to create enough space for walking, which assures the simultaneous interaction of the readers.

Orientation, location, and size are thus fundamental qualities for characterizing the *environment*, or the space where the visualization reading occurs. Environment is a term that is part of ecological psychology, a visual theory introduced by James J. Gibson that he used to describe a closed system where human and non-human actors mutually interact [8]. For him, each human has its *surroundings*, which correspond to its individual perspective on the environment. Humans interact through their own surroundings, which make visible and invisible the *affordances* that the environment can offer. Affordance is a term commonly used in different scientific disciplines to refer to the general interaction between two actors. More precisely, it refers to all the opportunities that a thing, a person, or a space makes available to others. Donald Norman, for instance, uses the concept of affordance when referring to the opportunities of interaction that the everyday objects offer to users [18].

The concepts of environment, surroundings, and affordance help to more precisely define the interaction

with a visualization. The visualization is not a mere object related to its reader, it is part of a system, i.e. the environment, which is composed of different actors such as the reader. Visualization and the reader are the basic pairing which makes the interaction possible. However, with respect to the first case study, the reader is not alone: more readers can interact simultaneously with the same visualization, and within the same environment. In addition, orientation, location, and size are all elements that characterize the environment and encourage certain interaction over others. Large floor visualizations, for instance, invite exploration by walking instead of by using a mouse. As a result, the visualization reading becomes a more complex system to which many actors, human and non-human, contribute.

ENAC Research Day 2016

The second case study was organized in collaboration with the ENAC, the school that groups together the institutes of architecture, civil engineering, and environmental engineering within the EPFL. Each year the ENAC deanship organizes a Research Day event for which all its scholars are invited. This event is a time to foster new synergies through different activities such as conferences, workshops, and showcases. The ENAC Research Day of 2016 was the ideal opportunity to share a visual representation of the school itself, entitled Affinity Map, in the form of a walkable visualization. The idea was to stimulate a public debate about the organization of the school and sensitize its members to the issue of visual self-representation.

The Affinity Map was a sophisticated visualization that presented the general organization of the ENAC scholars through their affinities. But what exactly is an affinity? The term *affinity* describes the intellectual and operational closeness that may bring, or has brought, people to work together. And what exactly is a map? The term map is used to indicate that the visualization is an instrument for a specific use. For example, large organizations are difficult to grasp in their wholeness and data visualization can help for this purpose; the Affinity Map is thus a possible solution to the problem of governance in large academic organizations such as the ENAC.

The Affinity Map followed the relational model of networks, arranging the nodes according to the strengths of their ties. The Affinity Map was, however, an unusual network in that its one thousand scholars were grouped by laboratories through a double structure of links: several chord diagrams constituted a larger hexagonal network (see figure 4). In addition, the type of the link relation was made visible. The result was a visualization able to represent the complexity of an academic organization through a multi-level and multidimensional network [24,26].

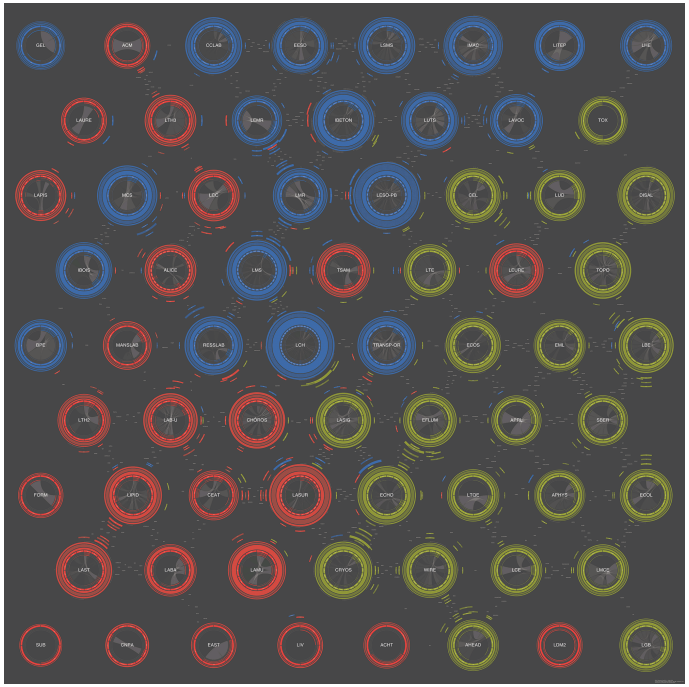

Figure 4: The map of affinities shows ENAC laboratories organized in a hexagonal network according to their actual and potential collaborations.

The location chosen for the installation was the building of architecture, whose center hosted a large foyer that was a way station for a lot of students and scholars. That foyer was an ideal spot to situate the visualization as its location assured a high volume of people would pass through. A search was run to find a cheaper material for printing because the available space allowed the creation of a walkable surface that would be larger than the first case study. During the search, another company offered to print on the tarpaulin, a heavy waterproof covering usually employed in truck trailers. The cost estimate was not lower for the material price but rather for the laying, as it did not require a specialist whose hourly labor cost would be high. According to the budget restrictions, the foyer's square footage, and the printer size limits, a visualization that encompassed 250 square meters was finally produced (see figure 5). Three surfaces measuring 5 by 15 were printed, making the most of the machinery's maximum width. Successively, a truck carried these prints from Lucerne to Lausanne where they were lay in side-by-side.

Figure 5: The walkable visualization measuring 250 square meters is unveiled during the ENAC Research Day.
@ Alexandre Gonzalez 2016

Contemplators and Participants

The ENAC Research Day was a pretext to go one step further, experimenting with a more complex environment. Indeed, the foyer was characterized by a much bigger walkable space, as well as by the presence of two levels of balconies that allowed readers to step ten meters away from the visualization. As a result, the map could be read from either a close or a distant point of view, in other words from either a close or a distant reading. Although these terms represent an abstraction of the digital humanist's approach to the study of a corpus of documents [17], their meaning is here brought back to the physical sense of distance, which might recall the tension that exists between the overview and the details of the visual information-seeking mantra [27]. What might be referred to as *close reading* happened by walking on the visualization. That action was similar to the interaction of the first case study, where readers accessed the details of visual information up close. On the other hand, *distant reading* occurred when the readers overlooked the visualization from the balconies. That behavior resembled the bird's eye view typical of cartographic projections, which gives an expansive view of the whole map. The two affordances offered readers access to different information: close reading was appropriate for looking inside the laboratories to the level of the individuals and their affinities, while distant reading was suitable for looking at laboratories as basic elements. Although Rudolf Arnheim thought floor visualizations discouraged the detached contemplation that cartography usually provides [1:13], in this case study the balconies offered a solution to the problem of the closeness by regulating the distance of the reading.

Upon reflection, however, it is interesting to note that that double distance of reading was effective because of the multiple levels of the map, without them the experiment would not have been successful. The Affinity Map was indeed designed to display different levels of information corresponding to the school hierarchy: namely to scholars, laboratories, institutes, and the whole organization. Such levels of information were blended into a unique visualization using different sizes: scholars as small typographical elements, and institutes as colors characterizing the large laboratory circles. Whereas topographic representation relies on a reduction of information according to the mapping scale, the Affinity Map yields a *continuity* integrating visual elements of different sizes. This continuity is not simulated through images of different resolutions as in the case of Google Maps, but is real as its focus is based on an optic zoom [14]. The readers can decide the information they wish to see by moving back and forth from the visualization.

The human movement of zooming by walking suggests a fictional comparison. Jonathan Swift wrote a book about the travels of his character Lemuel Gulliver, first a surgeon and then a captain of several ships [28]. In his exploration of imaginary worlds, Gulliver visited two places of different scales: an island called Lilliput where inhabitants were much smaller than him, and the land of Brobdingnag that was populated by giant-sized people. He learned what it meant to be smaller and bigger, like the readers during the ENAC Research Day. But what exactly did it mean to be smaller and bigger for the readers? Readers can either be contemplators or participants. The small reader was a participant, walking around to discover the smallest pieces of information. Its trajectory was a line that creates a

further level of information on the visualization, indicating the areas of interest. The position of the readers varied inversely when they were on the balconies, from which they were contemplators. They were able to observe other participants from there who were decoding not only the map, but also its usage (see figure 6).

The public presentation of the Affinity Map was a time for getting to know each other, but it was also a time to make the work of the ENAC scholars publicly viewable. Making an individual identity public is not an easy task, and neither is having one own identity shown publicly. In particular, two situations emerged during the ENAC Research Day. A laboratory director did not receive the invitation to fill out the annual report and, consequently, the relative research group representation was pretty empty. There was no solution for the public visualization, but the relative data were completed the next week and the online map was updated. Another laboratory director had the publication index completely empty. That was another problem related to the data, which was solved in a few weeks through the identification of the problem, which was related to the data input. Both situations required a certain sensitivity as the professors were not happy with their public image. However, the operation of revealing data was important for two reasons: spotting the errors, and make individuals aware of the data they enter or, more generally, their digital identity.

Figure 6: Readers from the balconies look at individuals on the visualization as a form of supplementary information. @ Alain Herzog 2016

Digital Floor Installations

The two case studies presented in these pages are examples of static images. However, floor visualizations can be dynamic and this section illustrates the different digital installations recently produced by Obscura Digital and Google.

Obscura Digital created a dynamic floor visualization in 2011, called Connections, for the *F8 conference*, which is hosted annually by Facebook. Multiple overhead projectors mapped a network visualization on the floor, while a device identified few attendees who were equipped with RFID in the projection area [19]. The result was a dynamic network of individuals related by their common interests in Facebook. The major feature of this visualization is the identification of the readers, and the resulting customization. This customization leads the reader to information more relevant to them through a filter on the data. However, this technology also has some limitations. First, external viewers might not find the information relevant that is being filtered according to the active readers. Second, dynamic visualizations do not offer steady references to lead the readers as the digital representation is always different.

The same year, Google created another dynamic floor visualization at the *Pavillon de l'Arsenal* in Paris. The installation was based on Google Maps, the software used to show the city of Paris on 37 square meters of high-resolution screens [20]. A control station situated at the base of the visualization allowed the reader to pan or zoom in and out. In addition, viewers could walk around the visualization on the catwalk that surrounded the map. The installation was attractive because it is rare to find a map of such size and detail. Furthermore, the view from the catwalks was impressive, the quality of the image was excellent, and the circulation of the readers gave different points of view (as in the case of the ENAC Research Day, the combination of close and distant reading enriched the reading experience). However, two limitations affected the installation. First, only one person at a time could interact with the map, making the other readers mere passive observers and, second, a close reading was not possible as the readers cannot walk on the visualization.

The potential of these dynamic floor visualizations is significant, especially with the constant evolution of technology that will allow for more seamless use. Some of the current limitations are purely technical, like the fact that only a few readers are able to interact simultaneously on the map. Other limitations are economic, for instance the need for screens, projectors, graphic cards, software, and professionals make the budget of dynamic visualizations very high, largely exceeding the creation of a static walkable visualization which remains more affordable.

Circulation of Readers and Knowledge

As previously written, it is reductive to consider a visualization without the larger context. The reader, in particular, is a necessary actor in this larger context in order to make sense of a visualization. As art exists when visitors interact with artworks [6], likewise the reading exists when a reader interacts with a visualization. In addition, the relationship between reader and visualization is particularly strong when the reader is represented in the visualization itself. The experience of the reader, indeed, relies on the act of self-recognition [23].

Walkable visualizations are situated in public environments in order to foster participation, making these objects not only shared [11], but above all public [16]. This specific setting allows for social interaction, making the visualization reading *collective*. Glances move around the visualization as readers search for their own selves in a collective performance bore by many readers. Once a reader finds themselves, the distance between the reader and its representation is equal to zero. What happens next is a transformation from self-recognition into the act of collective recognition: the readers no longer search only for themselves, but also for their peers. Looking at the individuals, the reading appears as a multitude of acts of self-recognition; looking at the whole, the reading seems more like a crowded activity of collective recognition. The visual representation and the individuals are unified through the act of a collective recognition.

The collective reading is helped, no doubt, by the size of the visualization. Walkable visualizations are indeed able to gather many readers on the same area in a sort of collective interaction. However, this interaction is not just between the visualization and the readers, but it is, above all, among the readers who are the protagonists of the performance.

The environment that exists around the walkable visualization offers different affordances. The main affordance is represented by the reading itself in which the visualization offers its information to the readers. However, a specific affordance of walkable visualization is represented by the movement of the readers within the environment. While visualizations on computer screens oblige the reader to stay still, walkable visualizations encourage the circulation of individuals. The readers have to walk around in order to experience the visualization from different points of view. This movement is similar to the behavior of a sculptor: to understand the volume of their artwork, the sculptor is obliged to look at the statue from every angle. Likewise, the circulation of the reader is a way to assimilate the many facets of information.

However, the movement does not concern a specific reader, but rather the collective. The trajectory that a reader forms through their movement is part of a larger *meshwork* that is similar to the pattern left by animals on the snow [15]. The meshwork shows the usage of the visualization through the circulation of the readers, but, more specifically, it shows how the readers meet each other through interactions (see figure 7).

Reading a visualization on the screen of a laptop or a mobile phone is usually an *intimate* activity that the reader performs alone [10]. Indeed, small screens favor a one-to-one reading. However, when the size of the media becomes bigger, as in the case of walkable visualization, the reading becomes social. It is not just because the size of the screen can host more users at the same time, but also because the size makes the screen content public and visible from longer distances [26]. The size of the walkable visualization fosters encounters between readers browsing the environment. And encounters stimulate discussion among the readers. As Philippe Starck commented on the poor functionality of his beautiful juicer when he claimed that it is an object that would begin discussions, walkable visualizations may be considered spaces to begin discussions as well. Indeed, the public dimension of the walkable visualization is important because it

creates a social space. Reasoning by analogy, it can be said that there exist three spaces: the space of the practice where the daily work takes place, the space of the representation that is aimed at visually representing the practice, and the space of the self-recognition where the readers meet and discuss both the natural and the represented spaces.

The point of this section is that if the intimate reading brings new insights, the social reading creates knowledge. Assuming that knowledge is the scientific, literary, and intellectual culture that is agreed between specialists of the same field, the way to improve that knowledge is a constructive discussion between these specialists. During the two case studies the collectives of research were both represented and invited to the reading. It was a moment for them to realize to being part of a larger collective through the recognition of the single and the collective self. An open discussion is the basis of every solid community. Data visualization, in such cases, allows members of a collective to explore the wholeness of their own organization, reflecting on its current state and the following steps towards its future. As Paul Ricoeur wrote, the self-recognition brings forth two directions: the past and the future [21]. The past is represented by the memories of digital traces that have been transformed into the visualization, while the future is represented by the promises readers make to plan a common future.

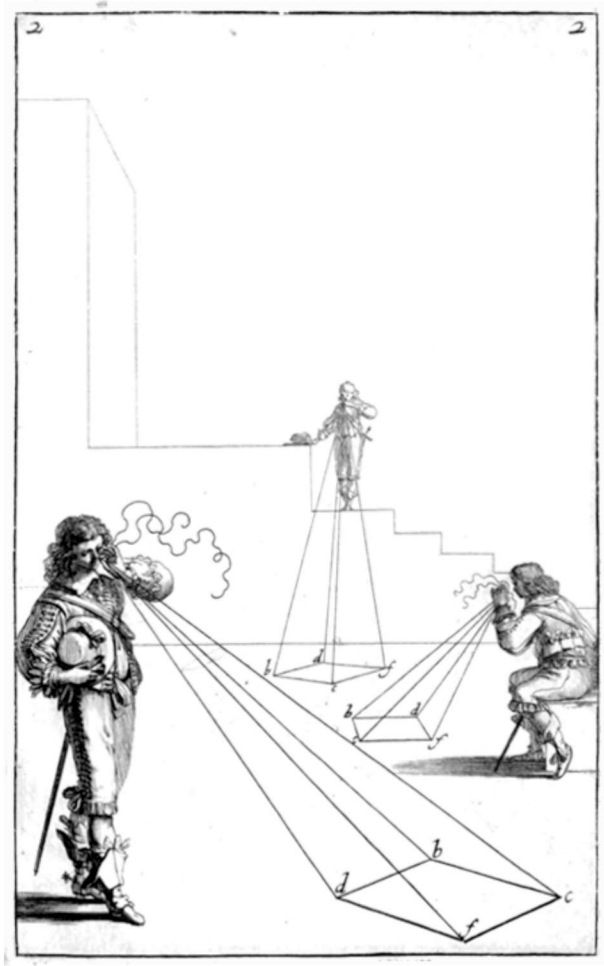

Figure 7: Readers circulating in the environment looking at the walkable visualization from different perspectives [5].

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